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ABSTRACT

This training manual discusses both the advantages and limitations of aerial application of pesticides. Other topics included are: agricultural aircraft equipment, dispersal accessories, drift control, calibration, spray testing, granular materials testing, operations, and personal safety. Safety check lists are given for pilots, ground crew, and flagmen. Charts and formulas are given for calculation of acreage and materials. (BB)

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Applicator Training Manual for:

AERIAL APPLICATION OF PESTICIDES

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UNIVERSITY OF KENTUCKY · COLLEGE OF AGRICULTURE · COOPERATIVE EXTENSION SERVICE
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INTRODUCTION

The aerial application of pesticides has several advantages for the modern agricultural producer. When properly managed, aerial application offers speed of dispersal, accessibility to crops on which ground equipment cannot operate, and reasonable cost. In many cases, the advantages also include more timely applications and, therefore, better utilization of pesticide materials.

The full advantages of aerial application are more likely to be realized when its use is preplanned. Development of a planned aerial application program will require good cooperation between pilot and grower. It should be based upon the grower's specific problems and the overall scope of his operation. Any plan must also recognize the potential dangers to people, other crops and the environment. After a plan has been developed, it is essential that it be followed as closely as possible in order to return maximum benefits to both the producer and the applicator.

Limitations on aerial application do exist and should be recognized. These include weather hazards, fixed obstacles, field size and shape, the distance from the point of application to the landing area, and the danger of contamination of nearby areas due to drift or misapplication. Perhaps the greatest single limiting factor is the pilot himself. A competent and effective performance by the pilot returns many benefits. Haphazard or careless applications can be harmful to the crop, the grower and the applicator, and are beneficial to no one.

AGRICULTURAL AIRCRAFT EQUIPMENT

Equipment for aerial pesticide application is limited to either fixed or rotary wing aircraft. Regardless of the choice, there are at least a few general features which should be considered. These are as follows:

1. *Pilot's fresh air supply*—Filtered air for the pilot to breathe is necessary because it is nearly impossible for the pilot to avoid flying back through some of the swath of previous flight passes. If a filtered-air helmet is not available, the pilot should at least wear an approved respirator.
2. *Fuselage features*—Enclosed fuselages should be fitted with cleanout panels for the regular removal of corrosive sprays and dusts. Spray pumps, filters, and control valves should be easily accessible for maintenance and repair.
3. *Maintenance*—The seasonal use of agricultural aircraft might suggest a pattern of inspection and repair during the idle, off-season periods. However, the critical demands of agricultural flying call for all the regular maintenance checks at all required intervals to ensure that the aircraft is in first class order at all times.

Two of the more important advantages of fixed wing aircraft are a high speed of application and a large payload capacity per dollar invested. Maneuverability is adequate, though not equal to the rotary wing aircraft. One of the limitations of fixed wing equipment is the necessity of a designated landing area, which may not always be in close proximity to the application area.

Rotary wing aircraft offers the advantages of extreme maneuverability and speed variation, and may be operated in almost any local area. Pilots of these crafts must also be competent, alert, and have

knowledge of the area and the limitations of their crafts. Rotary wing flying puts a special demand on the pilot to perform application with minimum time loss in turns, hovering and loading, since this type aircraft is more expensive to operate per unit of flying time than fixed wing aircraft.

DISPERSAL ACCESSORIES

Metering and dispersal are key functions of all pesticide-applying aircraft. Metering must be accurate for calibration and for the uniform, controlled delivery of liquids and solid material.

Liquid dispersal systems consist of a hydraulic circuit including pump, tank, hose, boom, filters, regulators and metering nozzles. These systems may be wind-driven or directly powered from the aircraft engine. The pump system must deliver large quantities of liquid material per unit of time. This often means that maximum output is available only at high engine RPM. For this reason, certain aircraft must be in flight to develop top delivery. Pumps and agitators must be designed to handle the desired nozzle output plus approximately 5 P.S.I. for line friction and agitation. Fairly low pressure (35 to 45 P.S.I.) high volume centrifugal pumps may be used for water base materials. Shear, or air friction across the nozzle opening, serves to provide material break-up. Bi-fluid or microbial sprays call for special pumps.

Standard, dilute volume spray equipment which has a range of 1/2 to 5 gallons per acre or more must have adequate piping. The main piping and fittings should have an inside diameter of at least 1-1/2" in order to carry heavy volumes of liquid. For rates of 1/2 to 2 gallons per acre, all piping should have at least a 1" diameter.

Filter screens at the nozzles and line filters protect nozzles and other parts from wear and clogging. Screen sizes of 50 to 100 mesh will be used, depending on nozzle orifice size. Pressure gauges located beyond the line filter indicate whether the line is clogged or opened. Line filters should be cleaned daily during spray operation.

Ultra Low Volume (ULV) equipment ranges in capacity from a few ounces to 1/2 gallon per acre. Special metering and atomizing attachments such as Micronair, Mini-spin and Airfoil are frequently used to aid in droplet break-up. These spiral, rotating nozzles may be wind driven or driven from the aircraft. Wind driven nozzles are dependent upon air speed and may fail when the craft is operating at reduced speed. Ultra Low Volume systems use a 3/8" inside diameter for the main line, hoses and fittings. Hoses for intermediate nozzles may be 1/8" inside diameter. The use of concentrate sprays (no water added) increases the density of the material and allows a faster rate of all. This process is limited to certain materials and is subject to a drift hazard. Flying heights of 5 to 15 feet above ground contribute to uniformity. Since ULV systems are not commonly used in Kentucky, the discussion in this publication will more generally apply to other types of equipment.

Booms are required to support nozzles along the wingspan of the craft. Booms must be strong, airfoil shaped and located near the trailing edge of the wing to offer minimum drag. Clearance between the control surfaces of the wing and the boom is essential. End caps on booms should be removable for cleaning. The location of outboard nozzles on the end of the boom is critical, since the wing end and main rotor vortex are used to develop the width of the pattern. End nozzles must be inboard enough to prevent wing tip vortexes from trapping fine droplets. Such entrapment creates uneven distribution and drift. Propeller rotation shifts the spray from right to left as the pilot sees it. Nozzles need shifting to the right with respect to the fuselage to compensate for this.

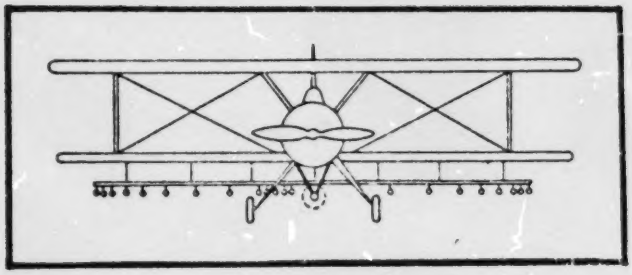


Figure 1. Variable Distance Nozzle Placement

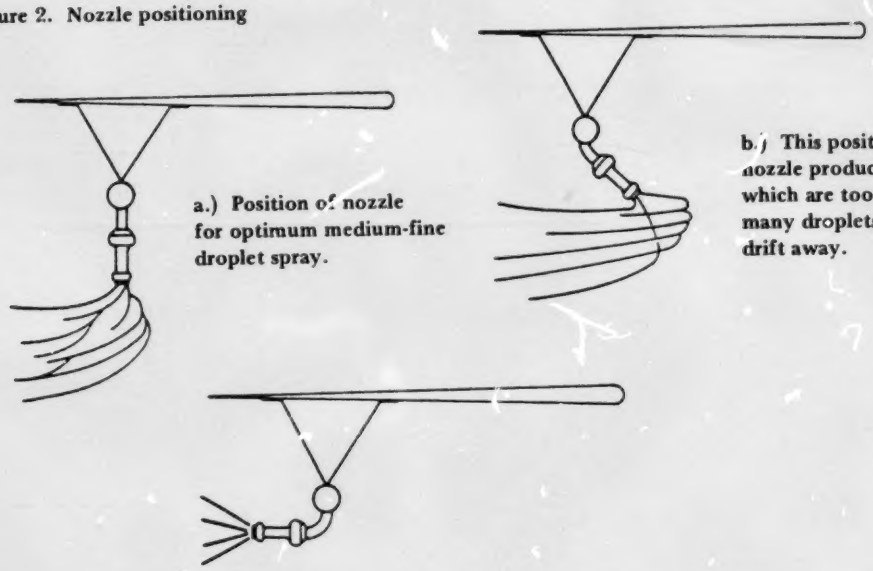
Ultra Low Volume systems require supply lines to the metering spinners only. Usually no boom is needed.

Nozzles are a critical part of aircraft spray equipment. Their selection, location, calibration and testing are essential factors.

The selection of nozzles is based on manufacturers' recommendations. Care must be exercised not to limit line pressure below 30 to 45 P.S.I. for water solutions. Special nozzles which entrain air or mix fluids in the tips are available. These are classified as foaming and bi-fluid systems. Nozzles for handling emulsions and slurries must have larger orifices.

Droplet size is greatly affected by nozzle orientation on the boom. More shear and liquid break-up may be obtained by orienting nozzles with the direction of flight. A swivel action is desirable. Nozzle types, in order of break-up or particle size, are: (1) fine—hollow cone; (2) intermediate—flat fan; (3) coarse—solid cone. Droplet size may also be controlled by the type of mixture being used (example: water emulsion or chemical wetting agent, etc.). Other influencing factors are the density, viscosity and surface tension of the liquid, and the evaporative conditions in the air between the point of release from the aircraft and the point of impingement on the ground.

Figure 2. Nozzle positioning



a.) Position of nozzle for optimum medium-fine droplet spray.

b.) This position of the nozzle produces droplets which are too fine; many droplets will drift away.

c.) This nozzle position produces droplets which are too coarse. Streaking and uneven coverage results.

For safety and economic considerations, positive shut-off control is essential. This may be attained through the use of diaphram or ball check valves or a suction return control. Diaphram nozzles are considered more efficient. All types require maintenance to ensure proper performance.

Spray systems for rotary wing aircraft include tanks mounted on the side of the frame in line with the rotor shaft. A common cross pipe feeds the engine-driven pump. Filter, regulator and control valves are attached to the lower frame of the fuselage in view of the pilot. Boom and nozzles may be mounted on the rotor, frame, or toe of the skids, enabling the pilot to see them.

Granular dispersal systems are used for applying dust, impregnated granules, fertilizers and seed. A hopper with agitation must be provided to prevent bridging of fine material. Fine materials less than 60 mesh require agitators to prevent bridging. Frequent inspection of metering gates is required to ensure against leakage common under flight conditions of low pressure. The metering gate is the means of calibration. Size, shape, density and flowability of material all affect the swath width, application rate and pattern. The use of granular systems is on the decline in agricultural work.

DRIFT CONTROL

Spray or dust drift is one of the greatest hazards of aerial application in terms of pesticide misuse. The amount of drift depends upon three factors. They are: (1) the size of the droplets or particles; (2) the wind velocity; and (3) the height above the ground from which the pesticide is released.

Droplet size depends primarily upon the spray pressure, nozzle design and orientation, and the surface tension of the spray solution. The size of granular materials depends upon the particular formulation and can be controlled to some extent by screening. In the case of sprays, droplet size is generally increased by reducing pressures or increasing nozzle size. The use of surfactants tends to lower the surface tension of a spray solution and usually results in a smaller droplet size than when the same formulation is used without a surfactant. Examples of different nozzle orientations and their effect on droplet size are shown in Figure 2.

High wind velocities obviously increase the drift hazard as they carry the small droplets and particles away from their intended target. In many cases the distance can run into several miles. Winds tend to be least turbulent just before sunrise or just after sunset. The most gusts usually occur between 2 and 4 p.m. A 3 mile per hour wind is usually the maximum wind velocity which is recommended for aerial applications.

The height from which a pesticide is released is important because it effects the time required for the droplet or particle to reach the ground. The longer the time required, the more opportunity there is for the pesticide to move away from its intended target. It is also true that the wind velocity is lower close to the ground than at higher elevations. Therefore, the wind problem can also be minimized by holding the discharge height to a minimum.

Every possible effort should be made to control pesticide drift. The distances can be surprising. Table 1 shows the effect of particle size on pesticide drift. In general, the ideal size of particles for aerial pesticide application is 500 to 1000 microns. This will permit adequate coverage with minimum drift problems.

Table 1: Effect of Particle Size on Pesticide Drift

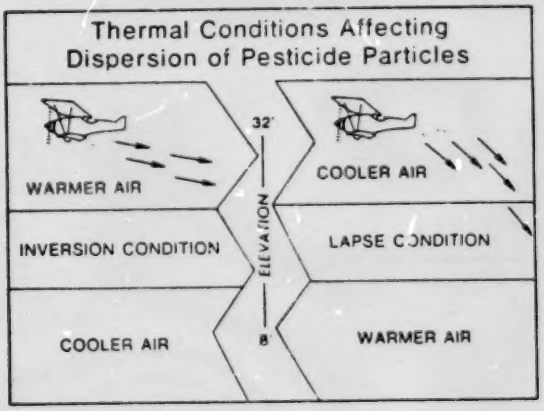
Droplet or Dust Particle Diameter (microns)			Distance of Drift*
0.5			388 miles
2			21 miles
5	(Fog)		3 miles
10			1 mile
100	(Mist)		409 feet
500 (1/50 inch)		(Light Rain)	7 feet
1000 (1/25 inch)		(Moderate Rain)	4.7 feet

**Pesticide released 10 feet above ground in a 3 mph wind.*

CALIBRATION

Fixed-wing aircraft and helicopters exhibit similar flight characteristics (wingtip vortex and main rotor vortex). Since the airflow patterns around and in the wake of each aircraft are sufficiently different, each type and series of aircraft needs testing. If the horsepower of the engine is changed, the type of propeller or wingtip shape will change the distribution pattern. Generalizations can be used to guide the operator on nozzle placement or granular disseminator adjustment. However, pattern testing is needed to check the effect of each feature added to the aircraft.

Pattern tests should be made in calm air to avoid cross-wind distortion. If wind is unavoidable, the tests should be made in a direction parallel to the wind. Testing should be carried out in winds less than 3 MPH at all times. The best time for this is in the early morning before the sun heats up the ground, creating eddies and inversions.



The tests must duplicate the use for which the application is required in terms of airspeed, height of flight, nozzle pressure or gate setting for granulars, nozzle angle and placement or disseminator adjustment, etc. It is better to test with the same materials to be applied if at all possible.

Substitute materials do not always act in quite the same manner as the chemicals. This is evident with granulars, where minor changes in the surface characteristics of the granulars (shape, surface finish, fineness or grind, etc.) alter the discharge rate.

SPRAY TESTING

The nozzle type and pressure should be selected for the material being used and the atomization required for the job. Machines should be calibrated often to compensate for wear. The application rate (gallons per acre) will be set by the chemical being applied and the crop being treated as listed on the manufacturer's label. Because each aircraft exhibits its own normal or effective swath width, this value should be used with the following tables to determine the acres per minute being treated.

Knowing the gallons per minute required, the number of nozzles can be calculated based on the manufacturer's data for that nozzle type and pressure. The pressure and the air speed are now fixed for the tests and the application.

Computation of Acreage and Materials

Formula:

$$\text{Acres covered} = \frac{\text{Length of Swath (miles)} \times \text{Width of Swath (ft.)}}{8.25}$$

The number of acres in a swath of given width and length can be determined from the acreage chart below.

EXAMPLE: An aircraft with a 40-foot effective swath treats a strip 1 mile long. To find the number of acres, look at the chart and follow the 40-foot vertical column down until it intersects the 1-mile line. The answer, to the nearest tenth, is 4.8 acres. For swath widths other than those shown, interpolate or use combinations of the figures shown. To determine the amount of chemical required, multiply the acres by the desired rate of application.

ACREAGE CHART

Swath Length (Miles)	Width in Feet							
	30	35	40	45	50	75	100	200
1/4	.9	1.1	1.2	1.4	1.5	2.3	3.0	6.1
1/2	1.8	2.1	2.4	2.7	3.0	4.5	6.1	12.1
3/4	2.7	3.2	3.6	4.1	4.6	6.8	9.1	18.2
1	3.6	4.2	4.8	5.5	6.1	9.1	12.1	24.2
2	7.2	8.4	9.8	10.9	12.1	18.2	24.2	48.5
3	10.8	12.6	14.5	16.4	18.2	27.3	36.4	72.7
4	14.4	16.8	19.4	21.8	24.2	36.4	48.5	97.0
5	18.0	21.0	24.2	27.3	30.3	45.5	60.6	121.1

Aircraft Calibration

Formula:

$$\text{Acres per minute} = \frac{2 \times \text{Swath Width} \times \text{Miles Per Hour}}{1{,}000}$$

The following acres-per-minute chart shows the rate at which spray or dry material can be applied when the swath width and speed of aircraft are known. For swath widths or aircraft speeds other than those shown, interpolate or use combinations of the figures shown. To find the rate of flow in gallons per minute or pounds per minute, multiply the acres per minute by the number of gallons or pounds per acre to be applied.

EXAMPLE: A 100 mile per hour aircraft has a 40-foot effective swath. On the acres-per-minute chart, follow the vertical 40-foot column down until the number opposite 100 miles per hour is intersected. The aircraft would cover 8.0 acres per minute. If 1 gallon of spray is to be applied per acre, the aircraft should be calibrated to disperse liquid at the rate of 1 X 8.0 or 8.0 gallons per minute. (If 10 pounds of dry material is to be applied per acre, the aircraft should be calibrated to disperse material at the rate of 10 X 8.0 or 80 pounds per minute.)

ACRES-PER-MINUTE CHART

Speed (M.P.H.)	Acres Per Minute Covered for a Given Swath Width (Feet)							
	30	35	40	45	50	75	100	200
40	2.4	2.8	3.2	3.6	4.0	6.0	8.0	16.0
50	3.0	3.5	4.0	4.5	5.0	7.5	10.0	20.0
60	3.6	4.2	4.8	5.4	6.0	9.0	12.0	24.0
70	4.2	4.9	5.6	6.3	7.0	10.5	14.0	28.0
80	4.8	5.6	6.4	7.2	8.0	12.0	16.0	32.0
90	5.4	6.3	7.2	8.1	9.0	13.5	18.0	36.0
100	6.0	7.0	8.0	9.0	10.0	15.0	20.0	40.0
110	6.6	7.7	8.8	9.9	11.0	16.5	22.0	44.0
120	7.2	8.4	9.6	10.8	12.0	18.0	24.0	48.0

To determine gallons (or pounds) per acre discharged from the aircraft, divide the gallons (or pounds) per minute discharged by the acres per minute that the aircraft covers in a swath.

Discharge Calibration

Having installed the desired type, size and number of nozzles, the output of the system should be checked to see that the correct discharge in gallons per minute is taking place. If the pump can be run at operating speed with the aircraft stationary, nozzle discharge can be checked with a measuring container and stop watch. Boom pressure must remain constant. If this stationary test cannot be done, the aircraft should be parked and the tank(s) filled with water to a suitable mark. The aircraft can then be flown and the spray system run for a timed period (30, 60, 90 or 120 seconds). The aircraft should then be brought back to the same point used previously and the amount of water determined by reading the tank scale(s) or refilling to the first mark using measuring devices.

Swath Pattern Tests:

With the application rate now established, the swath pattern should be checked to see that the distribution across the swath is as uniform as possible.

The best method of spray pattern testing consists of adding a tracer (dye, fluorescent material, etc.) to water in the tank(s) of the aircraft. The aircraft is then flown at the chosen air speed and height and the spraying system is operated at the chosen pressure. One pass is made over a row of target plates or cards laid out every 2 to 3 ft. at right angles to the direction of flight. The aircraft flies over the center of the target line that is 100 to 150 feet wide. The targets are collected and the spray deposit on each target is measured by the quantity of tracer. From the results, the distribution pattern of the swath can be determined. Corrections to the nozzle location can be made and the results checked by further testing.

A less satisfactory method is to lay out a roll of paper tape (adding machine tape) and visually inspect the resultant pattern. Interpretation of the spray pattern using this method is at best only a rough estimate of the uniformity of the deposit pattern.

GRANULAR MATERIALS TESTING

Disseminators are sensitive to adjust and the differences between granular materials have a pronounced effect on the rate of delivery and the pattern. Some disseminators are restricted as to quantity or type of materials being handled. These limitations should be checked before testing.

Discharge Calibration

Several runs should be made with the disseminating equipment installed to determine the quantity of material metered out for a given gate setting. If the disseminating equipment can be run with the aircraft on the ground, the material can be caught in large linen or paper bags and weighed. Ram-air disseminators require flight tests to get true discharge rates because the air currents and the engine vibration in flight affect the metering gate discharge rate. After running the disseminator for a given time (30, 60, 90, 120 seconds) the collected material is weighed. If flight tests are used, the quantity needed to refill the hopper is weighed. Where flight is needed to calibrate the system, use blank granulars (the granular carrier, without the pesticide, of the same type used to carry the chemical). Test for three gate settings to determine the gate setting that will give the required discharge in pounds per minute of granular material. Use the figures in Tables I and II to convert pounds per minute discharged to pounds per acre applied.

Swath Pattern Tests:

These tests are similar to the spray pattern tests except that the targets are replaced with containers (large buckets or 5-gallon grease pails). Use containers that have the same area of opening. The quantity caught in each container is measured with a sensitive balance, or the volume is determined in a narrow, graduated tube. From these readings and the spacing of the containers, the swath pattern can be drawn. Adjustments to rate and pattern are made and the tests are repeated to check the adjustments.

OPERATIONS

General:

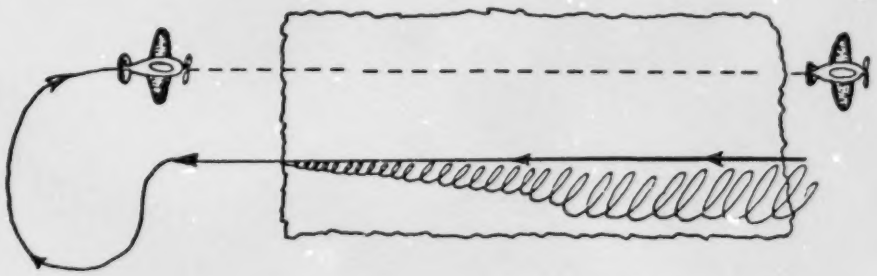
When an aircraft has been calibrated, the air speed, spraying pressure (or gate setting for

granules), height of flight and effective swath width are fixed. Applications must be made at the same settings.

The ferrying height between the airstrip and the field should be a minimum of 500 feet, loaded or empty. Avoid flying over farm buildings, feedlots or residential areas to avoid noise and accidental leakage problems. Courtesy to your neighbor costs so little and pays real dividends.

Field Flight Patterns:

With rectangular fields, the normal procedure is to fly back and forth across the field in parallel lines. Flight directions should be parallel to the long axis of the field because the number of turns are reduced. Where cross-winds occur, treatment should start on the downwind side of the field to save the pilot flying through the previous swath, as shown in the diagram below.



When this fits in with crop rows, the pilot can line up the aircraft with a crop row.

If the area is too rugged or steep for these patterns, flight lines should follow along the contours of the slopes. Where spot areas are too steep for contour work (mountainous terrain), make all treatments downslope. Avoid flying parallel to a stream or large lake if there is a tendency for drift toward the stream or lake.

Swath Marking:

Swaths can be marked with flags set above the height of the crop to guide the pilot. This method is useful if the field is going to be treated several times in a season.

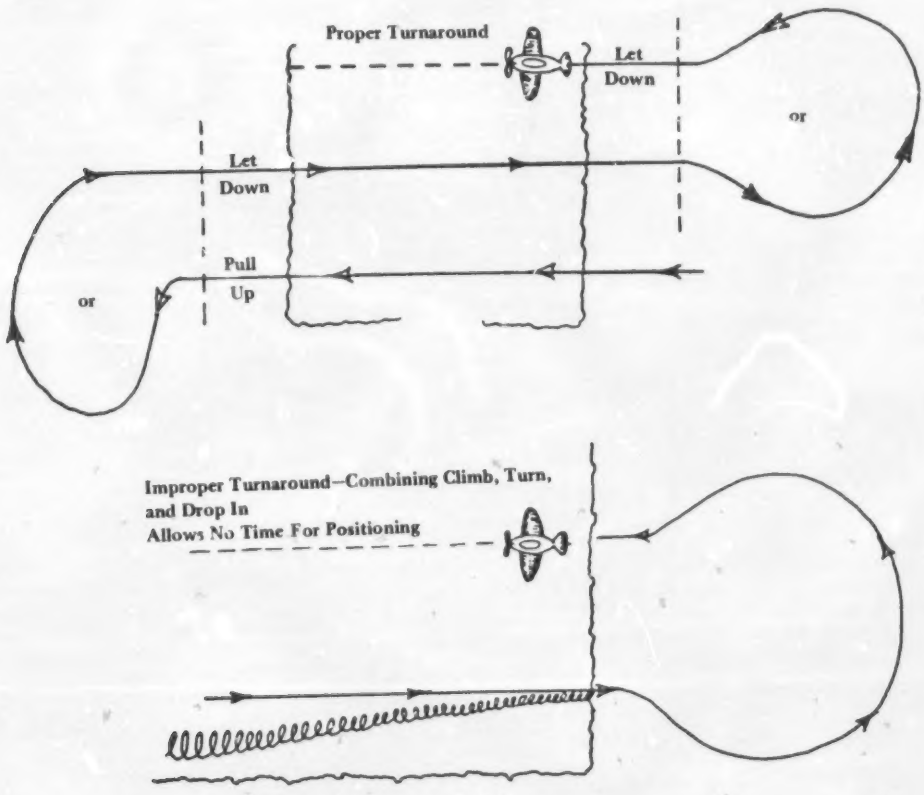
Two flagmen can be used to aid the pilot to line up across the field. When the pilot has lined up on his swath, the nearer flagman starts pacing off (or counting crop rows) to the next swath. *Flagmen should avoid being directly sprayed on and they should NEVER turn their backs toward an oncoming aircraft.* Federal orders prohibit using youths under 16 years of age as flagmen. Where the aircraft is flown parallel to a row crop, one flagman can be used to identify the swath row to the pilot.

Automatic flagmen (a swath marking device) are in common use now. These devices, attached to the aircraft and controlled by the pilot, release weighted streamers. These streamers give the pilot a visible mark to help him judge the next swath. Permanent markers in the fields are also in common use.

Turnaround:

At the end of each swath the pilot should stop the disseminator and pull up out of the field before beginning his turn. The turn should be completed before dropping into the field again. He

should fly far enough beyond the field for his turn to permit slight course corrections before dropping into the field again for the next swath, as shown in the following diagram.



Obstructions:

If obstructions occur (trees, power and telephone lines or buildings) at the beginning or end of the swath, it is preferable to turn the equipment on late or shut if off early. Then, when the field is completed, fly one or two swaths crosswise (parallel to the obstruction) to finish out the field. Do not run the disseminator when dropping in or pulling out of the field, since the pattern will be distorted. Obstructions inside the field should be treated in the same way. Skip the treatment as you avoid the obstruction, then at the finish, come back and spot treat the skipped part, flying at right angles to the rest of the job.

Areas adjacent to buildings, residences and livestock should be treated with extra care. Try to fly parallel to the property line, leaving a border of untreated crop to avoid possible drift onto unwanted areas. Adjust pullout and drop-in paths and avoid making turns over houses. Use caution when fields include or are adjacent to waterways, canals, or reservoirs. Treat fields with care if sensitive crops are planted next to them. Be certain that beekeepers are warned if they have beehives near the field to be treated and you are applying chemicals harmful to bees.

PERSONAL SAFETY

Pilot:

Pilots should never be involved in loading aircraft with pesticides. It is difficult, even with normal protective clothing and equipment, to load without some exposure. Accumulated exposures may bring on mild pesticide symptoms, including dizziness and fixed contraction of the pupils (miosis) of the eye. The latter symptom has been reported to have diminished visual acuity, especially at night. While these mild symptoms may not be serious to ground applicators, or the ground crew, they are potentially fatal to a pilot, especially in a night application. If pilots are exposed when dispensing pesticides and also during loading operations, this may accumulate enough dosage to trigger symptoms. When crosswinds occur, application should start on the downwind side of the field to avoid flying through the previous swath.

There is evidence that accidental direct eye contamination by organophosphates may cause contraction of the pupils from 7-10 days without any other symptoms. There have been several reports of fatally injured agricultural pilots who were using organophosphates and who had definite miosis discovered following the crash. While it is very difficult to assign "pilot error" crashes to pesticide exposure, present evidence suggests pesticide exposure should be kept to the minimum. Where symptoms characteristic of pesticide poisoning occur, the pilot should not fly until they are gone.

Remember, your body will tolerate small amounts of most pesticides. You can accumulate doses of pesticide from various operations—flying, loading mixing, cleaning, etc., but when you reach a certain level, symptoms will begin.

There have been a number of air crashes where the pilot was drenched with pesticide from a ruptured spray tank. Many pesticides are rapidly absorbed through the skin in addition to entry through the respiratory route. It is essential that contaminated clothing be removed as soon as possible and the pilot "streak" for the nearest water for washing—ditch, creek, pond, hose, etc. This is not the time for modesty. The California Department of Health has reported one pilot who was not critically injured in a crash but was splashed with TEPP and Phosdrin and died of organophosphate poisoning 20 minutes later. Similar poisonings can also occur with Paraquat or Parathion, two pesticides commonly encountered in Kentucky.

A filter or canister type respirator appropriate for the chemical being applied should be used. If one is needed for extended periods during hot weather, use a respirator and crash-helmet combination that is ventilated with fresh air.

Flagman:

It is essential that the flagman wear adequate protective clothing when exposed to pesticides. Pilots should not spray or dust over flagmen. Permanent markers are being used in increasing amounts by aerial applicators. These markers eliminate the possibility of exposure by flagmen.

Loading Crew:

The handling of very toxic pesticides, sometimes in concentrated forms, necessitates the wearing of proper protective clothing. Puddles of pesticide spilled in the mixing or loading area can penetrate improper footwear. Only liquid-proof or rubber boots should be worn.

AERIAL APPLICATION CHECK LIST

It is suggested that pilots and crew, including flagmen, review a check list at least weekly. It is easy to become complacent and careless.

Pilot Check List:

The pilot should do the following BEFORE, DURING and AFTER any application:

1. The pilot should not load or handle highly toxic pesticides during any operation, especially hazardous formulations.
2. Engines should be shut off during loading operations.
3. Hard helmets with pesticide respirators should be worn in flight.
4. Check the field and surrounding area prior to application and make sure there are no animals, humans, crops, waterways, streams and ponds that would be injured or contaminated either from direct application or drift.
5. Do not fly through the drift of an application.
6. Stop treatments if winds rise and create a drift hazard.
7. Do not turn on dispersal equipment or check the flow rate except in the area to be treated.
8. Refuse to fly if the customer does not read and understand the flagman check list. Also refuse if he insists on having pesticide applied in a manner and time which may create a hazard to crops, humans, animals, and surrounding environment.
9. Read the label yourself and know the hazardous characteristics of the pesticide.
10. Know how far and in what direction the chemical will drift.
11. Do not spray or dust over flagmen.
12. After completing the job, do not dump remnants on the field but carry them to the loading area and have the crew dispose of remnants in a safe manner.

Ground Crew Check List:

The ground crew should do the following BEFORE, DURING and AFTER any application. Also, the ground crew should be familiar with the pilot's check list.

1. The aircraft, especially the cockpit, should be cleaned frequently.
2. Tanks and hoppers should be tightly sealed so chemicals will not blow back over pilot.
3. Cover the hopper as soon as loading is completed.
4. Remove any chemical spilled near the fill opening.
5. When cleaning aircraft or other equipment, use extreme care and wear protective clothing.
6. Do not stand in or allow runoff water to splash on you.
7. Change clothing after washing aircraft and contaminated equipment.

Flagman Check List:

Where flagmen are used, they should do the following BEFORE, DURING and AFTER any application. A flagman should also be familiar with the pilot's check list. If the farmer is to assist the flagman, be sure he is familiar with this check list.

1. When the flagman arrives at the field to be treated, he should warn all people in the immediate area that an aircraft is going to treat a certain area. Ask these people to stay out of the area and avoid drift.
2. Avoid as much spray or dust as possible.
3. Wear the appropriate protective equipment for the pesticide being applied.
4. As soon as the aircraft is lined up with you for a pass, move over to the next position, but DO NOT TURN YOUR BACK ON AN APPROACHING AIRPLANE.
5. Stay at the field until the pilot has completed the job. If there is an accident, you may be able to help the pilot.
6. Carry a card or have printed on the work order, a copy of which you should have, the chemical being applied and any emergency instructions for the doctor in case someone is exposed to a toxic dose of the chemical.
7. Have a radio-equipped vehicle nearby so that you may contact your office for changes in instructions or emergency procedures.
8. Never allow a stand-in to perform your job without a thorough knowledge of this check list and the job he is to do.

THE OPPORTUNITY

The success or failure of aerial pesticide application depends as much or more upon the competency and performance of the pilot than on any other single factor. He must not only be an excellent pilot, but he must also have a knowledge of pests, pesticides, safety precautions, the environment, and the application equipment. He must be able to communicate and work with the individual producer. The wise and careful use of pesticides will help the farmer to increase his production and will help assure him continued use of the management tools which he needs in order to expand his productive capacity. The good aerial applicator has an opportunity to support and enhance the producer's efforts and to share in his successes. The careless or haphazard applicator has an opportunity to destroy the producers efforts, and . . . yes . . . to share in his disasters. The opportunity IS YOURS!!!!

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